

IGR J19140+098: A NEW INTEGRAL TRANSIENT

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ABSTRACT

IGR J19140+098 is a new X-ray transient, discovered by INTEGRAL during an observation of GRS 1915+105. The source presents strong variations on timescales from seconds to days. We present results of multiwavelength observations, including spectral analysis of INTEGRAL observations, and propose that IGR J19140+098 is a Galactic X-ray binary. Further classification of the source is also discussed.

Key words: X-rays; Binaries.

1. INTRODUCTION

X-ray transients are a subclass of X-ray binaries whose brightness can vary by a factor of more than 100. The main reason for those variations are changes in the mass accretion rate on to the compact object. The variations of the mass accretion rate can be related to an eccentric orbit, changes in the companion star, or instabilities of the accretion disk.

IGR J19140+098 (SIMBAD corrected name IGRJ19140+0951) is an X-ray transient that was detected by INTEGRAL (Hannikainen et al., 2003a) on March 6th during an observation of GRS 1915+105. It has also been observed later by Rossi X-ray Timing Explorer (RXTE) and ground-based optical and radio telescopes such as the Nordic Optical Telescope (NOT) and the Giant Meterwave Radio Telescope (GMRT).

2. X-RAY OBSERVATIONS

INTEGRAL observed GRS 1915+105 during revolution 48 (2003 Mar 6-9). A transient source was discovered (Hannikainen et al., 2003a,b) in the field, 1° from GRS 1915+105 (see Figure 1).

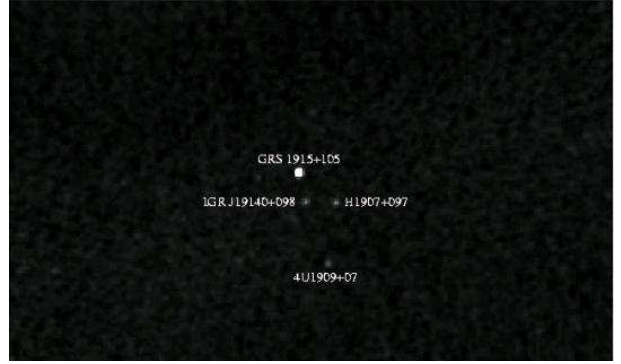


Figure 1. An ISGRI 20-40 keV mosaic image of the GRS 1915+105 field. For revolution 48, IGR J19140+098 is clearly detected. The height is $\sim 12^\circ$ and width 22° . North is up and East is to the left. Adapted from Hannikainen et al. (2003b).

Standard INTEGRAL off-line science analysis software (OSA) was used for the JEM-X (OSA version 3) and IBIS/ISGRI (version 2) data reductions. Mosaic images and combined spectra for the entire GRS 1915+105 pointing were created following the standard data reduction process (Goldwurm et al., 2003; Westergaard et al., 2003). The ISGRI 20-40 keV image of this observation is shown in Figure 1. The INTEGRAL position of IGR J19140+098 is $19^h13^m55^s + 09^\circ51'58''$, with an accuracy of 1'.

A 2.2 ksec RXTE observation was made on 2003 Mar 10 (see also Swank & Markwardt (2003)). The RXTE data was analyzed with the `rex` script available at the HEASARC web site. Proportional Counter Array (PCA) spectra and lightcurves (in 2-8 and 8-20 keV bands) were extracted with standard screening criteria. The PCA lightcurves (Figure 2) show some variations on timescales of one hundred seconds, but no periodicity is found. The observed hardness variations are not statistically significant. The timescale of the variations suggests a Galactic origin.

The spectra were analyzed with the XSPEC (ver-

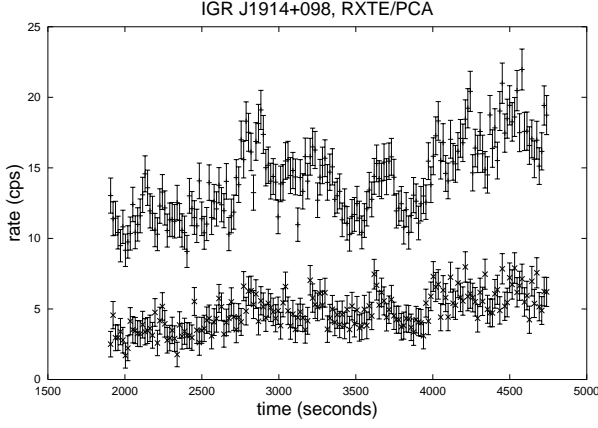


Figure 2. *RXTE/PCA* lightcurves for March 10th observation, in two energy bands (upper 2-8 keV, lower 8-20 keV). Variability on time scales of ~ 100 seconds is evident. No statistically significant periodicities or color variations were seen during the observation.

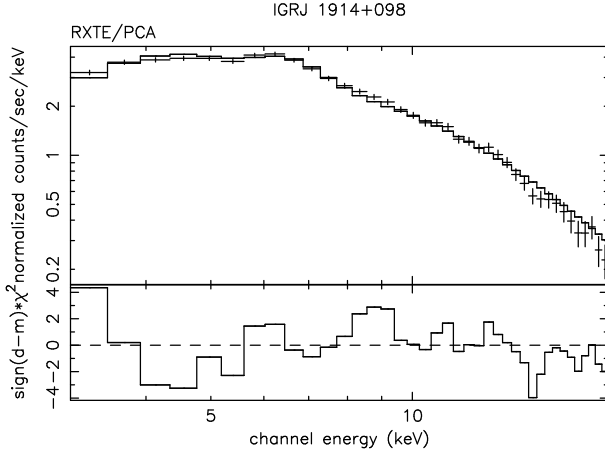


Figure 3. The *RXTE/PCA* spectrum taken on March 10th

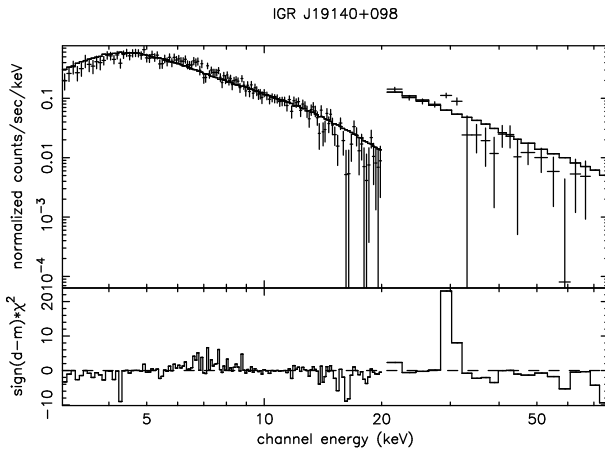


Figure 4. The *JEM-X* and *ISGRI* spectrum of Revolution 48.

Table 1. The results of the spectral fits. The X-ray flux is in the 5-20 keV band and corrected for absorption. For details, see the text.

	Mar 6-8	Mar 10	unit
F_X	38	8.5	$10^{-11} \text{ erg cm}^{-2} \text{ s}^{-2}$
PL α	2.8 ± 0.1	1.6 ± 0.1	
N_H	6 (fixed)	6 ± 1	10^{22} cm^{-2}
E_C	:	6.5 ± 0.2	keV
EW	:	0.6 ± 0.2	keV
χ^2	243	54	
dof	152	40	
Band	3-80	3-20	keV

sion 11.3) software. For PCA, the 3-20 keV energy range was used, and systematic errors of 1% have been used in the fitting. In the initial absorbed powerlaw fit, Large residuals clustering around 6 keV are found when the spectrum is fitted with an absorbed powerlaw. Adding a gaussian line at 6.5 keV to the model removed these residuals. With this model we obtain a χ^2_ν of 1.4. The hydrogen column is $6 \pm 1 \times 10^{22} \text{ cm}^{-2}$. The galactic column in this direction is $1.7 \times 10^{22} \text{ cm}^{-2}$ (*ftool nh*), the excess is probably either intrinsic to the system or caused by small-scale structures of the ISM. The powerlaw photon index is 1.62 ± 0.10 , and the 5 – 20 keV unabsorbed flux is $8.5 \times 10^{-11} \text{ erg cm}^{-2} \text{ s}^{-1}$, corresponding to $1.0 \times r_{\text{kpc}}^2 \times 10^{34} \text{ erg s}^{-1}$. The gaussian line center is at 6.5 keV and equivalent width is 600 eV, which is very strong for an X-ray binary.

We fitted the JEM-X data between 3-20 keV and ISGRI data between 20-80 keV. Systematic errors of 2% (10% for 4-7 keV data and 20% for 3-4 keV data) have been added to the JEM-X spectrum. The data can be fitted with a simple absorbed powerlaw model, with column density fixed to $6 \times 10^{22} \text{ cm}^{-2}$. No normalization constant has been used between the instruments, as fitting gave a result of 1.00 ± 0.01 for the constant. The fit has $\chi^2_\nu = 1.6$ that could be improved by 0.1 by adding an iron line, or allowing a freely varying absorbing column. However, removing the instrumental feature at 30 keV would improve the χ^2_ν by 0.2, so any smaller improvements to the fit can also be attributed to systematic effects. The powerlaw photon index is 2.8 ± 0.1 , and unabsorbed 5 – 20 keV flux during the INTEGRAL observation is $3.8 \times 10^{-10} \text{ erg cm}^{-2} \text{ s}^{-1}$, giving a luminosity of $4.5 \times r_{\text{kpc}}^2 \times 10^{34} \text{ erg s}^{-1}$.

The powerlaw photon indices of the ISGRI/JEM-X and PCA spectra are 2.8 vs 1.6, each with an error of 0.1. The 5-20 keV flux during the INTEGRAL observation is about four times higher than during the RXTE observation. (The 5-20 keV band is used instead of the more common 2-10 as the former is entirely covered by the instruments and less affected by absorption or possible low-energy Comptonization cut-off.) This suggests that a state tran-

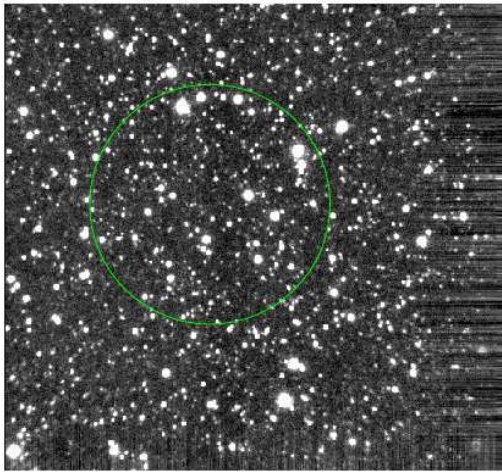


Figure 5. The field of IGR J19140+098 imaged in the K-band by NOT, with the INTEGRAL 1' error circle overlaid.

sition between a 'steep power-law' and a 'low-hard' state has been observed. Such states are characteristic of black hole low-mass X-ray binaries (see e.g. McClintock & Remillard (2003)), and therefore we suggest that IGR J19140+098 is a low-mass X-ray binary, possibly containing a black hole. To determine the nature of donor and compact object, further observations are needed.

IGR J19140+098 is in the error circle of the X-ray source EXO 1912+097 (Lu et al., 1996), so it probably has been detected by EXOSAT. (See also in't Zand et al. (2004) for BeppoSAX Wide Field Camera observations of the field.)

3. INFRARED AND RADIO OBSERVATIONS

The INTEGRAL field of IGR J19140+098 was observed with the Nordic Optical Telescope (NOT) in spring 2003. Infrared images (JHK) of the field were taken, but no obvious counterpart for the source could be detected. Unfortunately, the observations are too short to allow reliable photometry in any of the used bands. This summer, two nights of NOT observing time is allocated for further observations of this field.

The GMRT observations (Pandey et al., 2004) revealed one 3.5 mJy source within the error circle, but a probability of a spurious source at that brightness level is above 90%.

4. CONCLUSIONS

A new X-ray source, IGR J19140+098 has been discovered with INTEGRAL. Analysis of INTEGRAL and RXTE data shows that the spectral and temporal variability of IGR J19140+098 are best explained by a Galactic X-ray binary, preferably one

with a low-mass donor and a black hole. However, further observations are needed to determine the binary component types.

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